LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

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Investigating Components of Tourangeau's Cognitive Response Model in Survey Responses through Mouse Tracking

CIPHER conference

February 27th, 2025

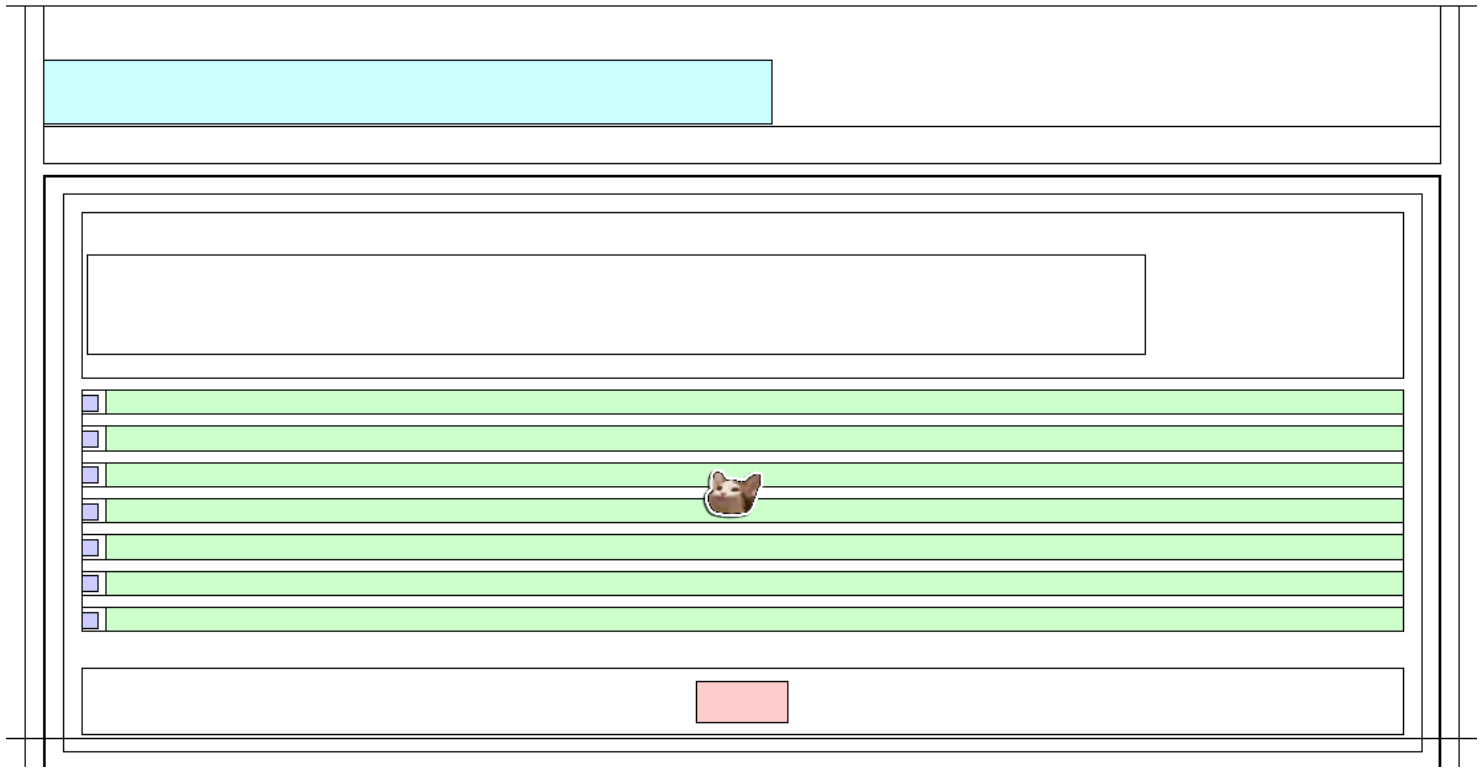
Research Question

- Monitoring web surveys
  - Consistency, fatigue, engagement, distractions, frustration
  - Difficult and ambiguous questions
    → Measurement errors
- Paradata
  - Response time
  - Response edits
  - Mouse movements

Couper, M. P. (2000). Web surveys: A review of issues and approaches. Public Opinion Quarterly, 64(4), 464–494. https://doi.org/10.1086/318641
Kreuter, F. (2013). Improving surveys with paradata: Analytic uses of process information. Wiley Series in Survey Methodology. Wiley. https://doi.org/10.1002/9781118596869

Mouse Tracking

- MouseTrap Package
- Recording movement, clicks, and hover patterns of a respondent's mouse
- **Movement**: Path of the mouse cursor
- **Clicks**
- **Hover Time**: Instances and time spent hovering over e.g., text or options
- **Y-flips**: Cursor moves back and forth between two or more response options before making a final selection
- **Distance**, **velocity** and **acceleration**



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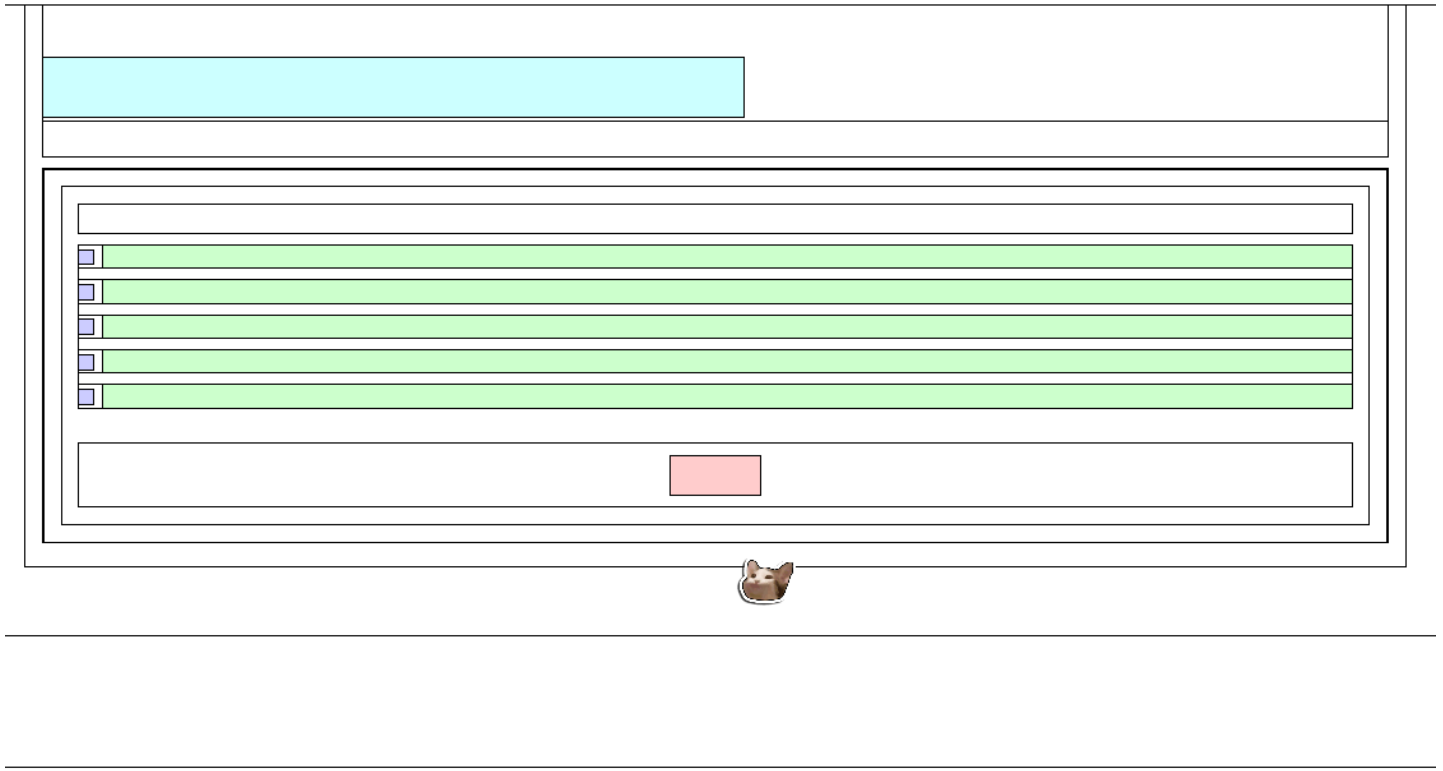

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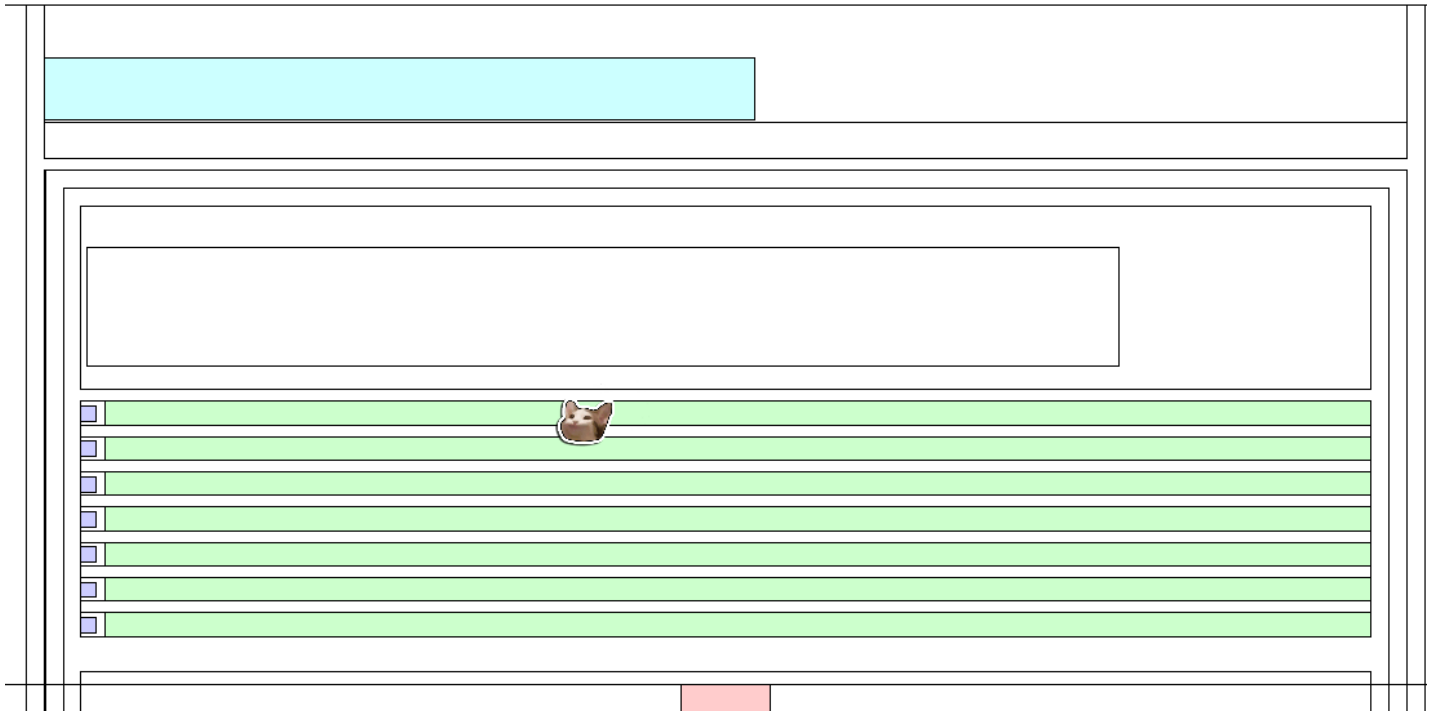

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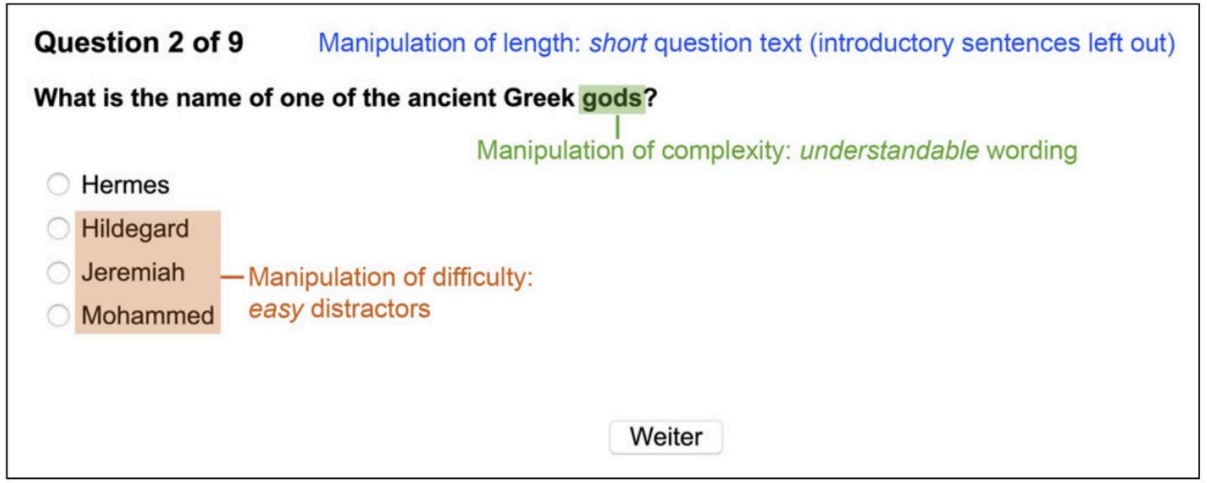
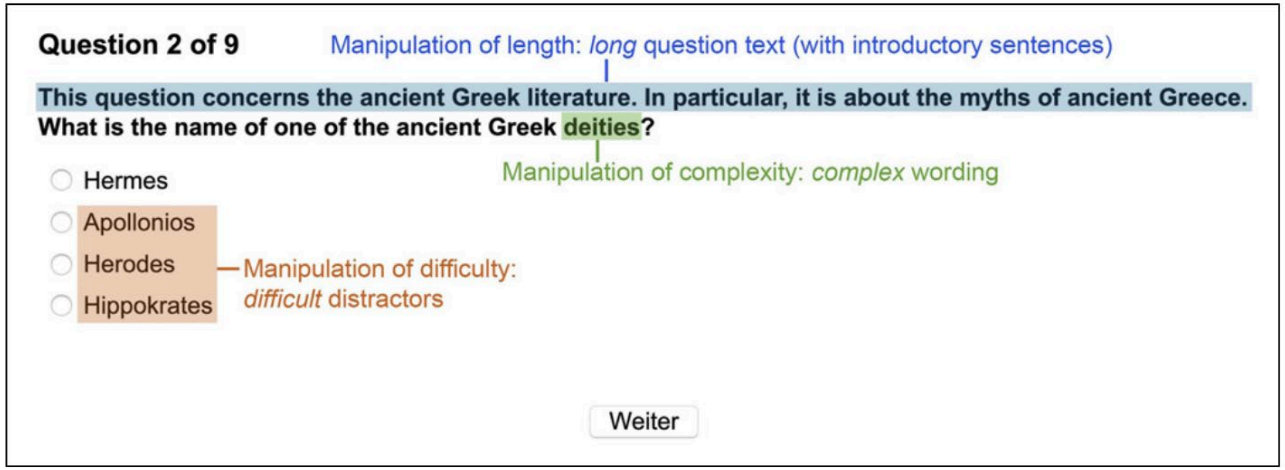
Previous research

- Research shows similarities between mouse tracking and eye tracking in detecting hesitation, attention and cognitive conflicts
- Detect disengagement and distraction
- Identifying difficult questions
- Optimizing survey design

- Identify underlying cognitive challenges?
- *Can a connection be found between the distinct cognitive challenges participants encounter when responding to online survey questions on one hand, and mouse trajectories on the other, and (how) does this relationship depend on the nature of the question?*





Huang, J., White, R. W., & Buscher, G. (2012). User see, user point: Gaze and mouse alignment in web search. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI), 1341–1350. https://doi.org/10.1145/2207676.2208591
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Methodology

- UAS End of Year survey 2024 (Survey 672): 9953 participants
- Questions from RFF climate insights study (2020)

Resources for the Future & Stanford University (2020). National Survey of Global Warming, https://www.rff.org/climateinsights/about-climate-insights/ https://media.rff.org/documents/ClimateInsights2020_GeneralTrends_Methodology.pdf

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Opinion (Q1): How much do you trust the things that scientists say about the environment?
- Completely
- A lot
- A moderate amount
- A little
- Not at all

Opinion (Q2): If the world's temperature did increase over the past 100 years, do you think this increase was caused mostly by things people did, mostly by natural causes, or about equally by things people did and by natural causes?
- Things people did
- Natural causes
- About equally
- Don't know

Behavior/factual (Q3): How much do you do now to deal with global warming compared to average people?
- A great deal
- A lot
- A moderate amount
- A little
- Nothing

Behavior/factual (Q4): As far as you know, would you say that average temperatures around the world have been higher in the last decade than before that, lower, or about the same?
- Higher
- Lower
- About the same
- Don't know

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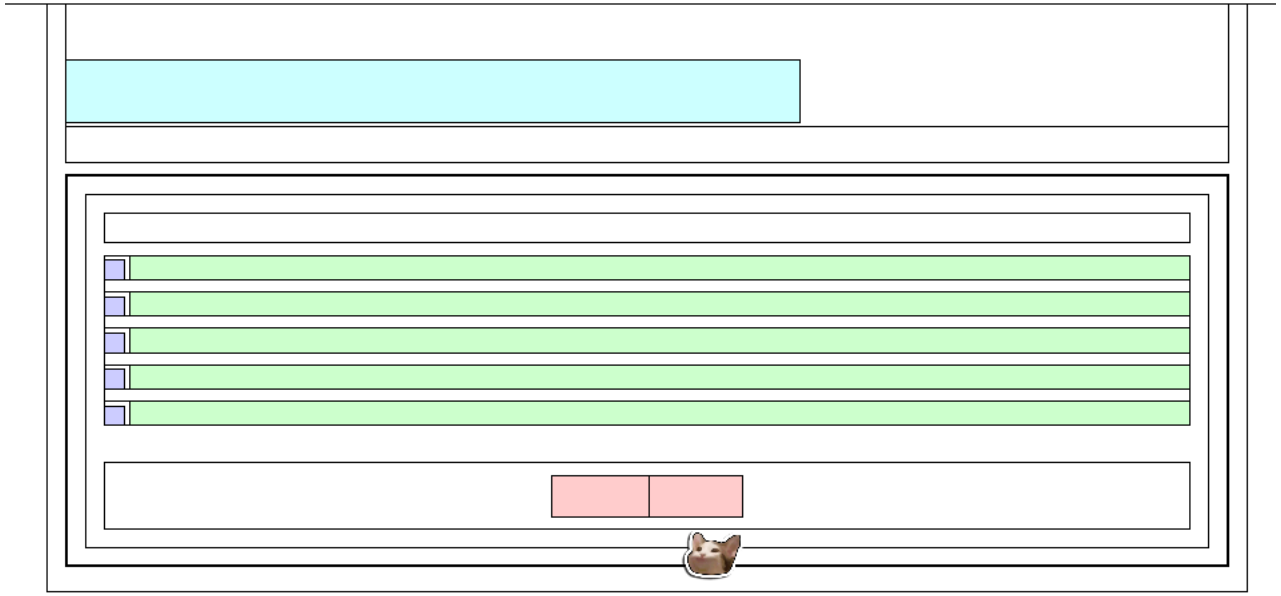

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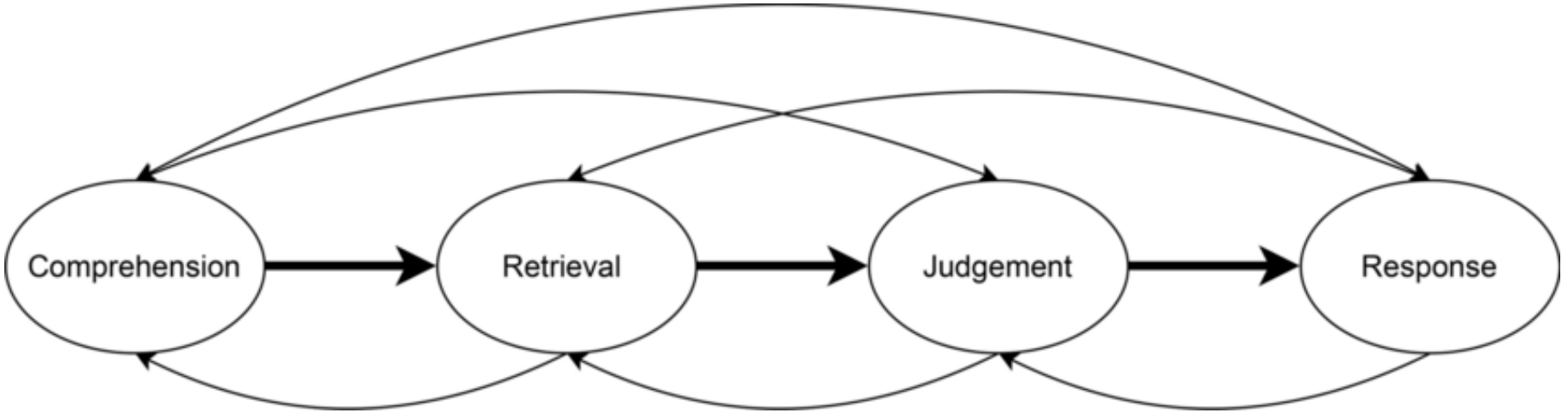
Tourangeau cognitive response model



How easy or difficult was it to understand what the previous question was asking?

How easy or difficult was it for you to think back to identify the information needed to answer the previous question?

How easy or difficult was it to reach your judgment for the previous question based on the information that came to mind?

How easy or difficult was it for you to give a response to the previous question that accurately reflects your true thoughts and feelings?

7-point scale: Very difficult → Very easy

Tourangeau, R. (2018), "The survey response process from a cognitive viewpoint", Quality Assurance in Education, Vol. 26 No. 2, pp. 169-181. https://doi.org/10.1108/QAE-06-2017-0034

Analysis

- Purpose: Train machine learning models to predict cognitive responses based on mouse movements
- 8 models: 2 questions types (opinion & factual) and 4 cognitive follow-up questions
  - Applying the classification models of Fernandéz-Fontello et al. (2022 & 2023)
  - Hovers, y-flips, x-flips, response time, initiation time
  - Personalization based on mouse tracking from baseline questions
- Preprocessing and data cleaning
  - Time per question, Spanish language, partial responses
  - Exclude participants using smartphones

What are you using to move the pointer around the screen while answering this survey?

- ○ A mouse (a handheld device you move to control the pointer on the screen)
- ○ A trackpad or touchpad (a flat area you touch to move the pointer on the screen)
- ○ A touchscreen (you touch the screen directly)
- ○ Something else, please specify:

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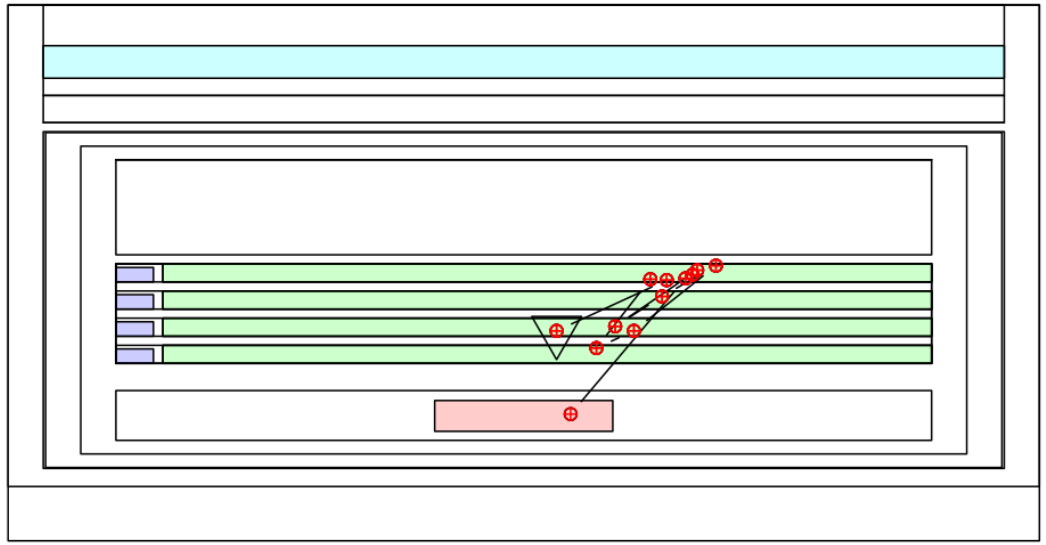
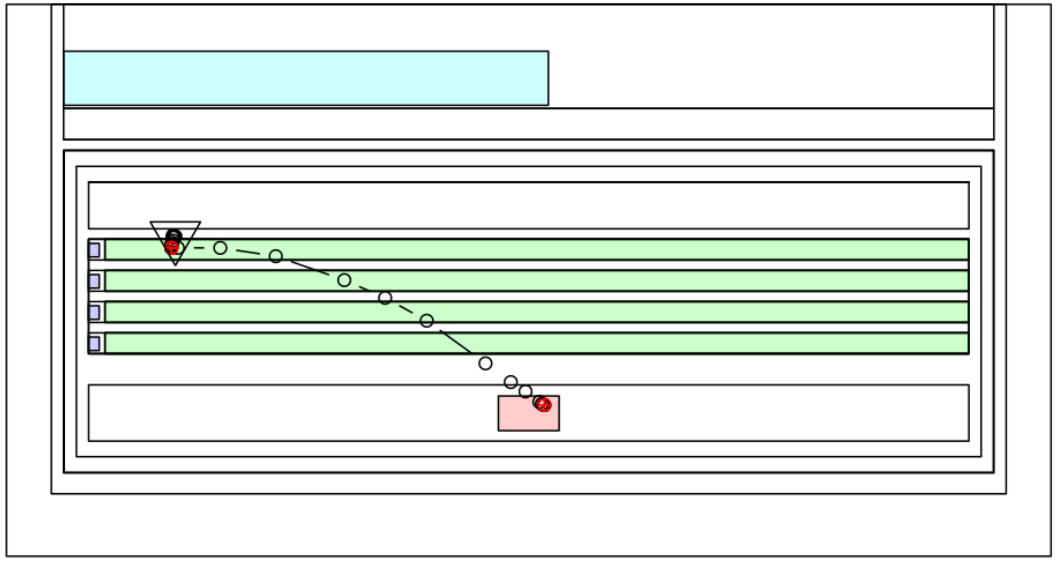
Preprocessing

- ~ 25% responded incorrectly to device question
  - Misunderstood it as their typical device
- Mouse movement events:
  - **Black triangle**: Start of a trajectory
  - **Black circle**: Registered location of the mouse in a trajectory
  - **Black line**: Connection of two consecutive points in a trajectory
  - **Red circle**: Click on mouse/tap on touchscreen
- Process
  - >50 events → Mouse
  - <10 events → Touch
  - 10-50 events → Manual classification





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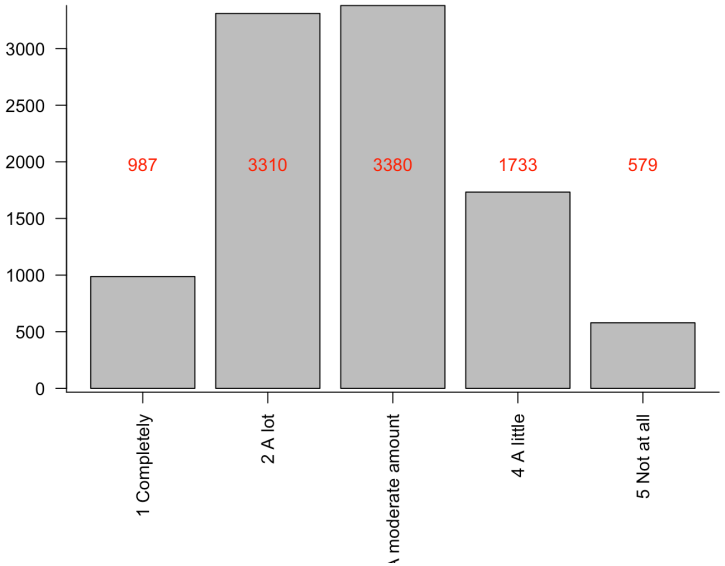

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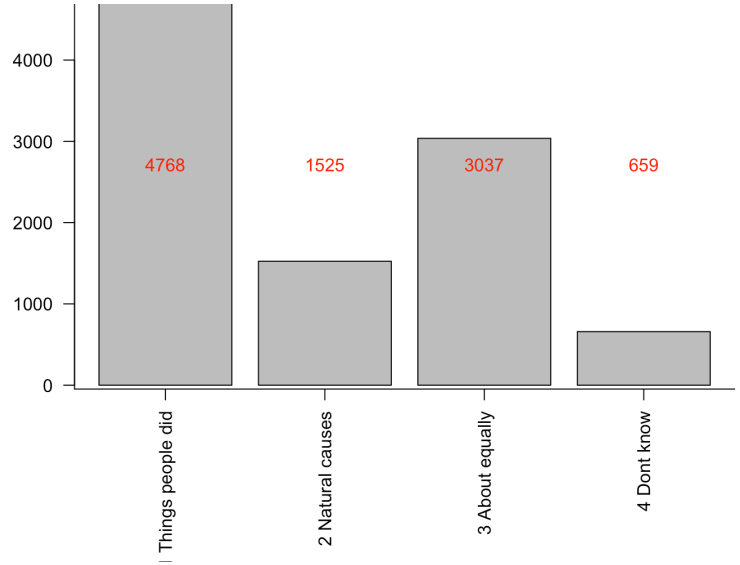

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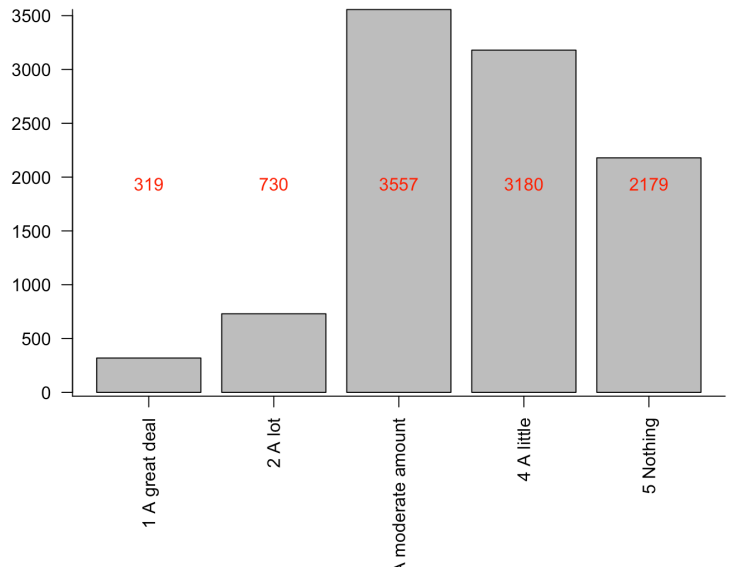

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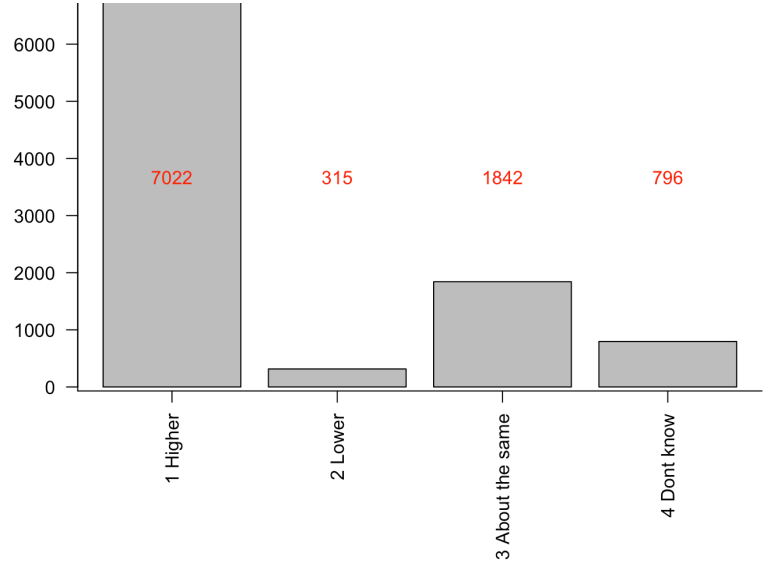

Next steps

- Model type
  - Binary → ordinal classification
- Dichotomization of response labels

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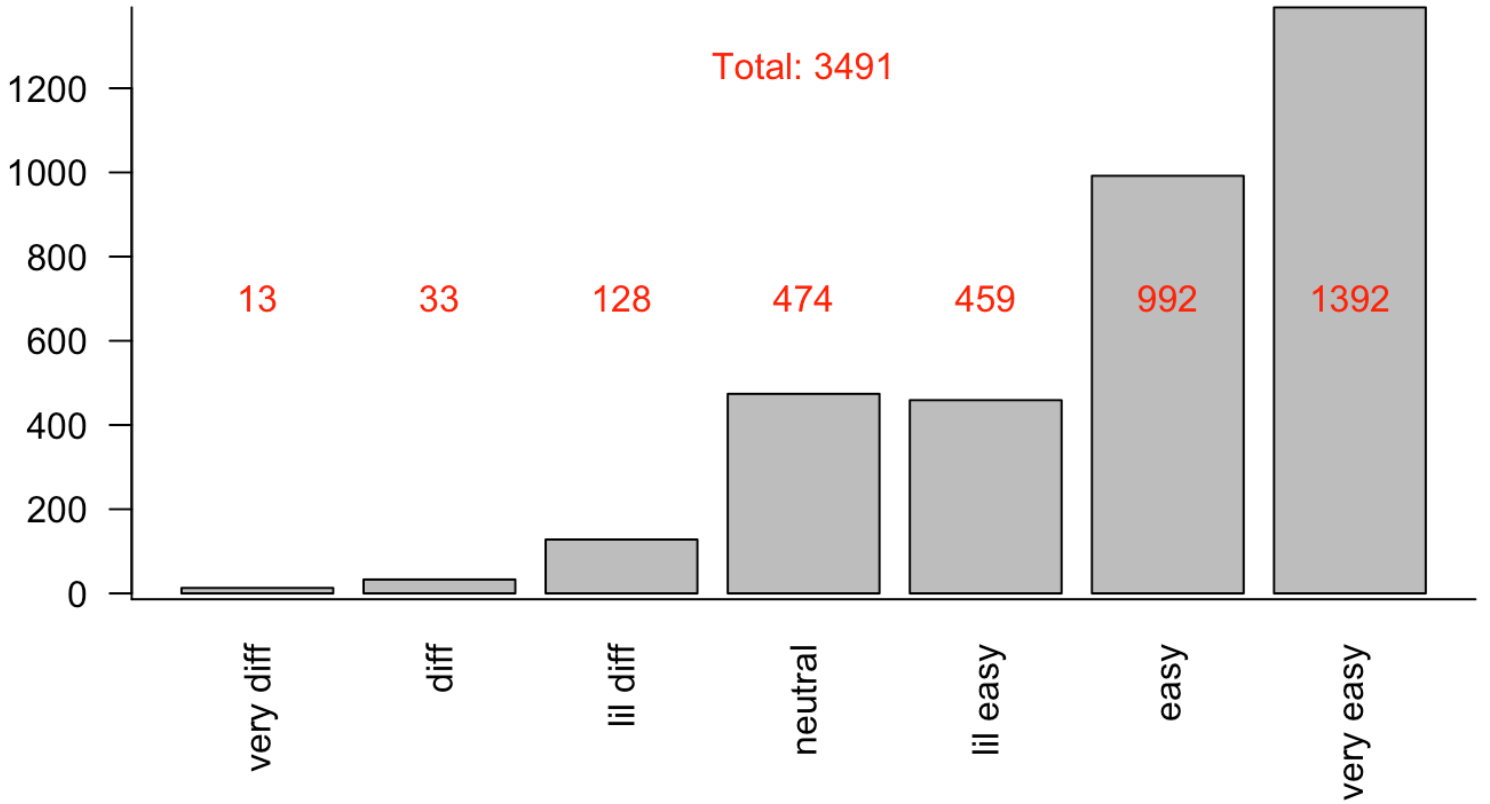

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